Recycling of textiles in Europe – what's the status?

Findings from the Study for the German Federal Ministry of Economic Cooperation and Development (BMZ) with a Focus on Recycling Technologies

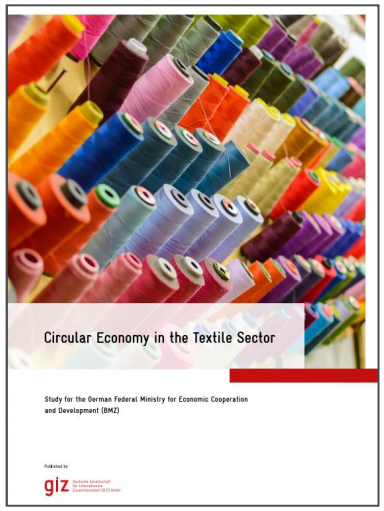
Peter Malodobry, Research Analyst

DAKOFA Seminar, Copenhagen, 25.06.2019

Content

adelphi

- Company Profile
- Services



- The Study & State of Play
- Textile Recycling Technologies

- Textile Sorting Technologies
- Barriers & Challanges & Solutions

- Questions and Discussion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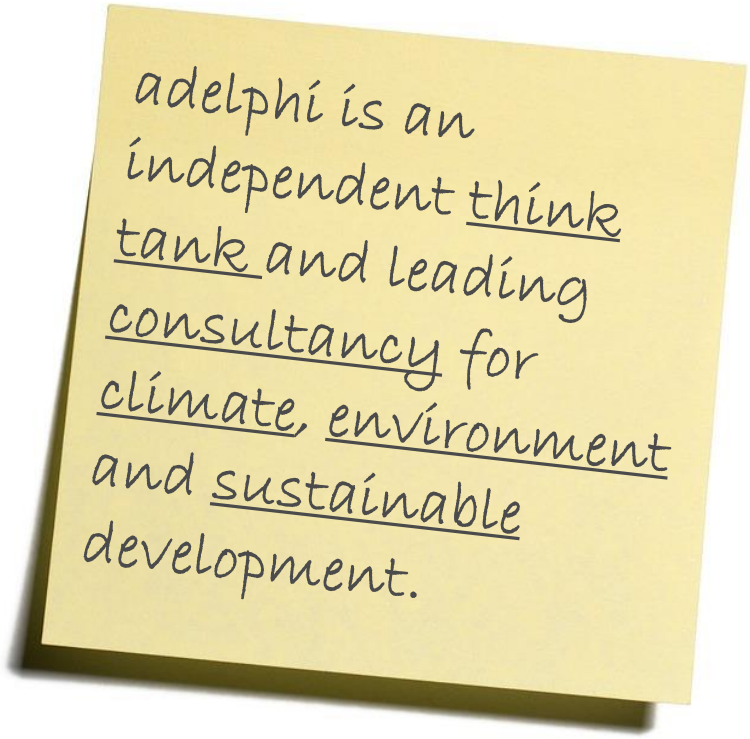


CLIMATE

ENERGY

RESOURCES

GREEN ECONOMY

SUSTAINABLE BUSINESS

GREEN FINANCE

PEACE & SECURITY

INTERNATIONAL COOPERATION

URBAN TRANSFORMATION

Our services

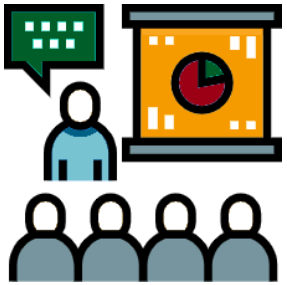
Provider of ideas and services for ecological, social, economic and political challenges

Our services in the subject area circular economy

Support policy makers in setting up frameworks

Advise to decision-makers from the public and private sector in all stages of **innovation development**

Organisation of **events, conferences**, awards & production / dissemination of **communication & PR material**



Project examples

From Grave to Cradle: E-waste Management in Ghana (E-MAGIN Ghana)

Closing Material Loops through EPR: Implementing the Waste Management Code in Georgia

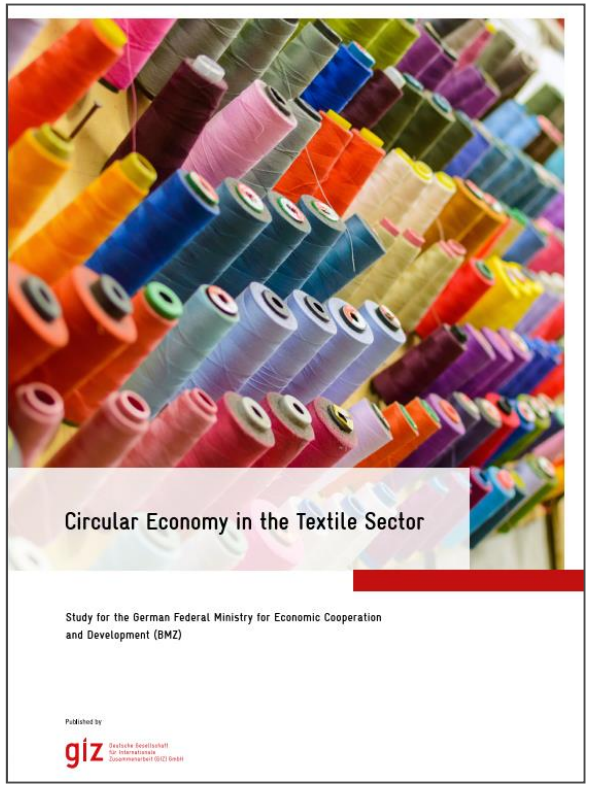
Our clients (selection)

International Institutions	Governments	Donors / Implementing Organisations	Companies / Associations
Europäische Kommission GD CLIM GD DEVCO GD ENTR	Die Bundesregierung AA BfN BMBF BMUB BMWi BMZ UBA	afd AGENCE FRANÇAISE DE DEVELOPPEMENT	Deutsche Bank
DESA UNDP UNEP UNIDO		G | M | F The German Marshall Fund of the United States STRENGTHENING TRANSATLANTIC COOPERATION	KUONI
IFC International Finance Corporation World Bank Group		giz	DEHOGA BUNDESVERBAND
	Foreign & Commonwealth Office	Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra Direktion für Entwicklung und Zusammenarbeit DEZA	Volkswagen
IUCN	USAID FROM THE AMERICAN PEOPLE	CDKN Climate & Development Knowledge Network	PARTSLIFE
OSZE	KFW	THE ROCKEFELLER FOUNDATION	Continental The Future in Motion

The study & state of play

The study

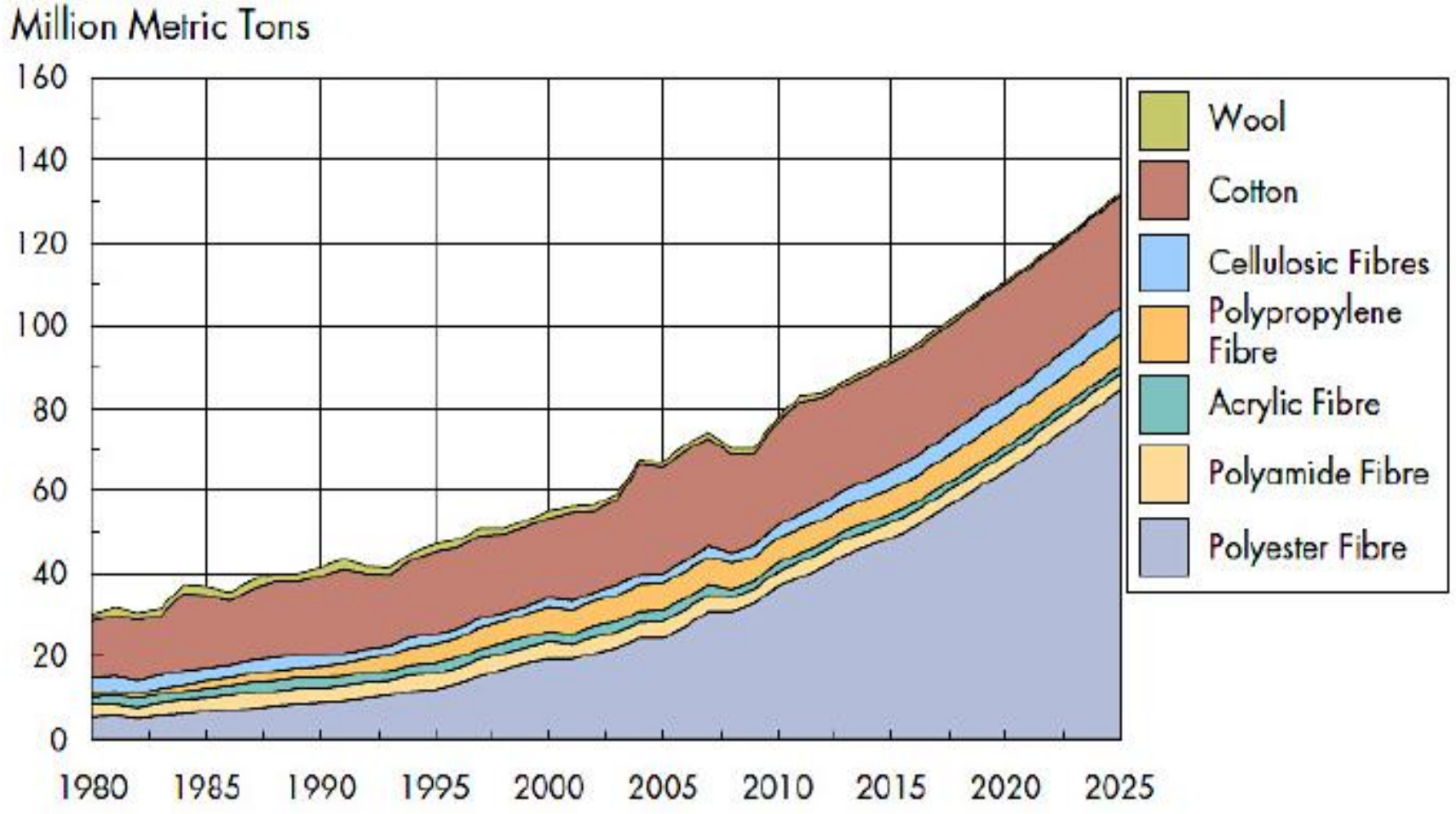
- **Duration: August - November 2018**
- **Project partners:** adelphi, CRADLE TO CRADLE E.V.
- **Task:** Developing a comprehensive study on recycling management in the textile sector
- **Focus:** Closing fibre loops in the apparel sector
- **Methodology:**
  - Literature research
  - 21 interviews with industry experts
  - Circular Textiles Symposium @ C2C Congress, 14th September 2018
  - Discussions with funding specialists



CRADLE 2 CRADLE CONGRESS 2018

State of Play

Since 1980, the production volume of textile fibres has tripled. However, only 1% of the fibres are circulated in closed loops.



Koszewska 2018

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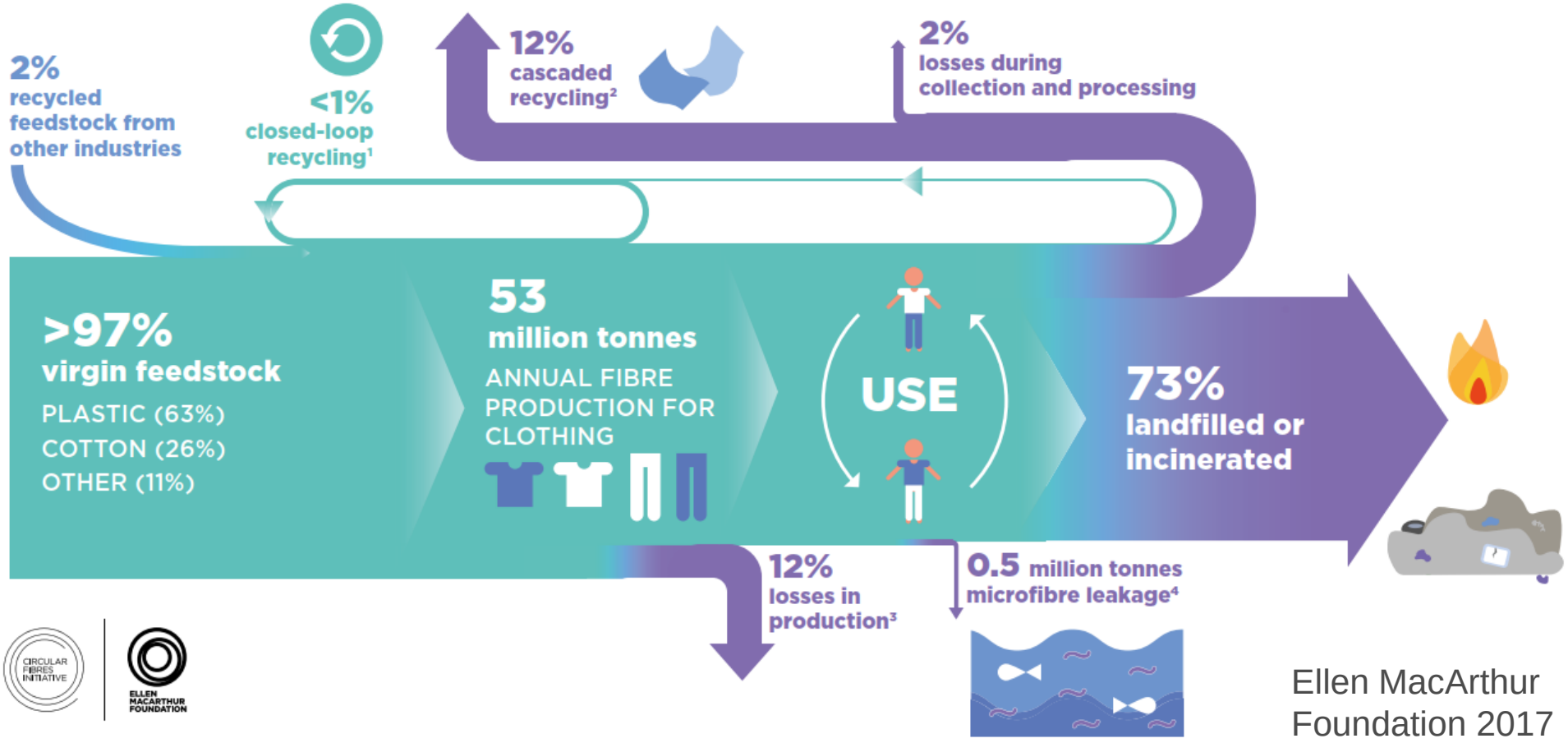
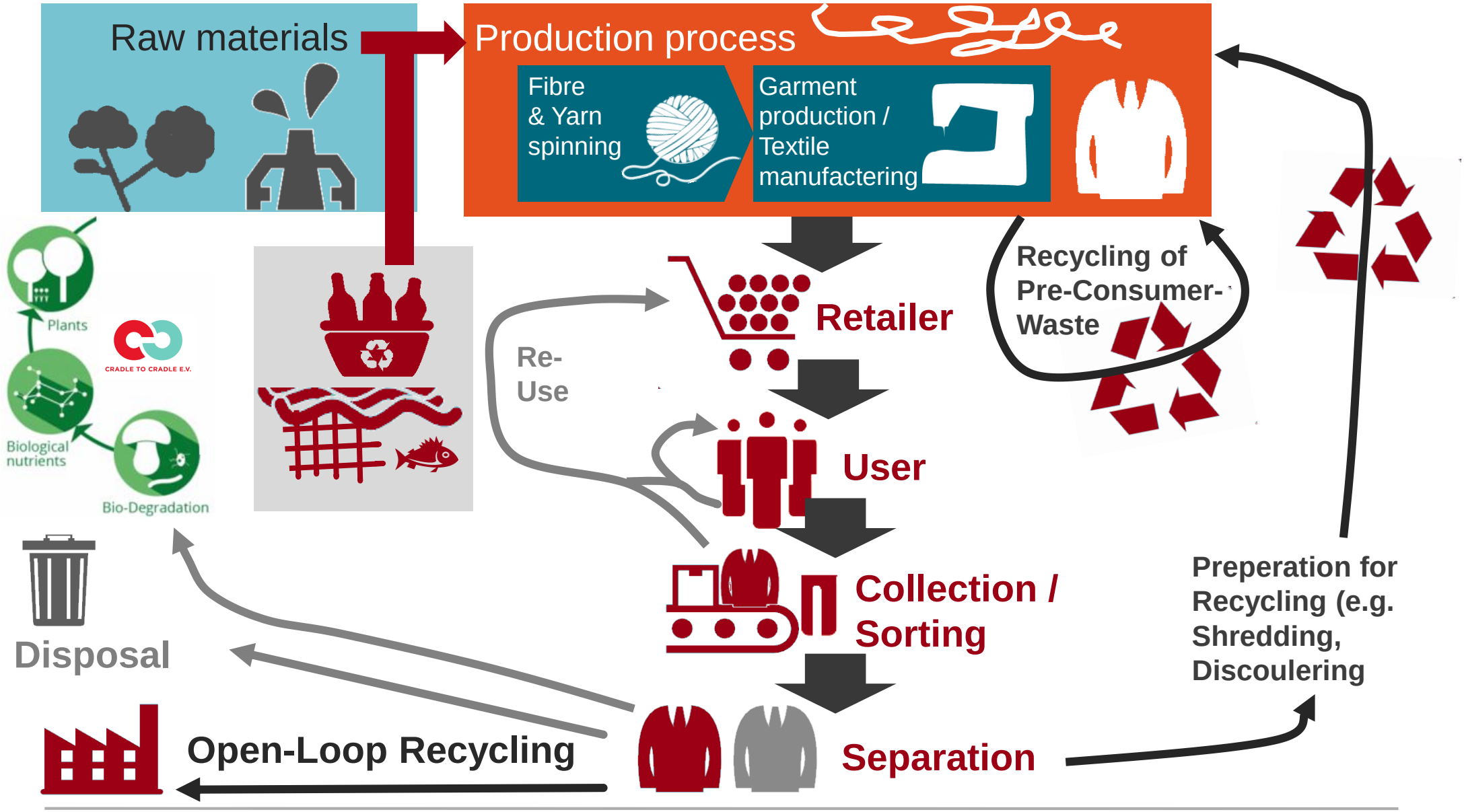


Ellen MacArthur Foundation 2017

1 Recycling of clothing into the same or similar quality applications
2 Recycling of clothing into other, lower-value applications such as insulation material, wiping cloths, or mattress stuffing
3 Includes factory offcuts and overstock liquidation
4 Plastic microfibres shed through the washing of all textiles released into the ocean

Textile recycling at a glance



Textile Recycling Technologies

Standard mechanical recycling (Fibre Recycling)

- Natural fibres (Cotton fabrics)
- Mechanical tearing of fibres, unravelling, grinding, defibrating and cutting
- Developed process (e.g. SOEX with H&M)
- Currently less than 0.1% of recycled amounts textiles is recycled into yarn and new textiles
- Reduction in use of new fibres
- Substitution of raw material production (cotton farming)
- Max 30 % recycled fibres
- Reduction of Fibre quality → Downcycling
- Ecologically questionable

© SOEX 2017

Standard chemical recycling

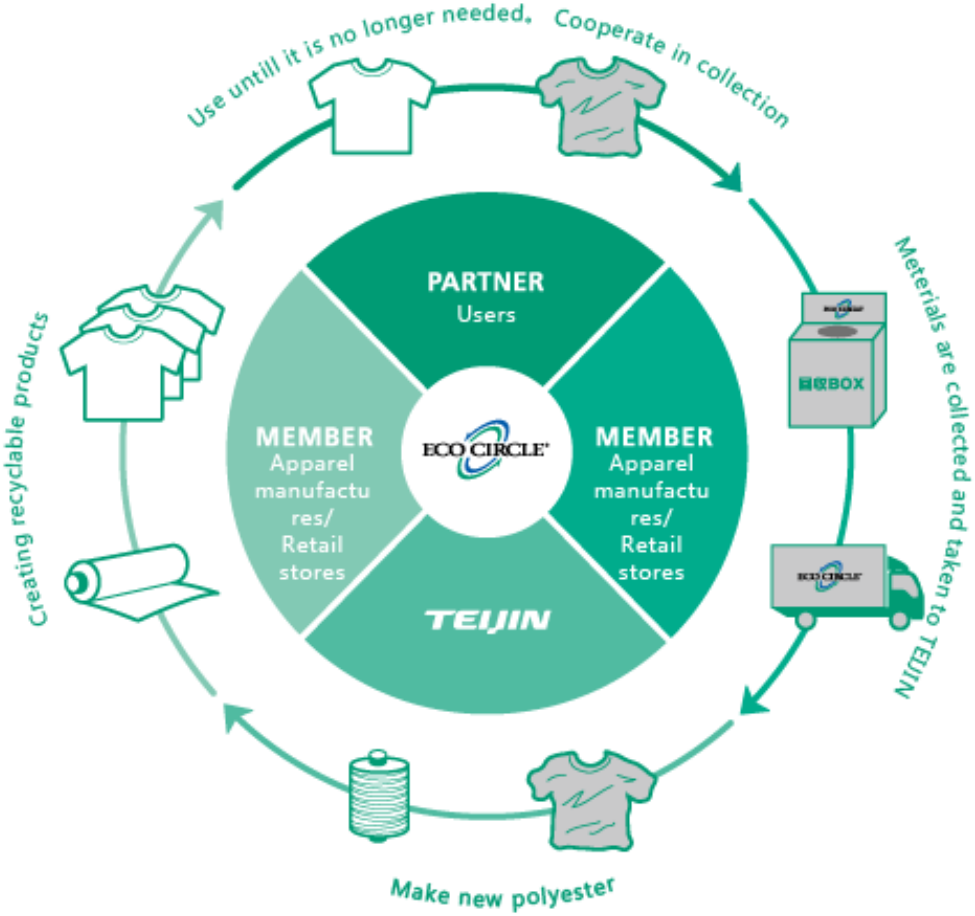
- Synthetic fibres (synthetic polyester as mostly used fibre)
- Textile materials are roughly cut up and decomposed into individual monomers by the addition of various chemicals

  → Feedstock to produce monomers of virgin quality
- Developed process (e.g. Teijin, Parley for the Ocean)
- Concerning natural fibres neither technologically nor economically mature
- Recycling without affecting quality
- Same price as conventional fibres
- In currently developed processes restricted to single-origin articles
- High energy consumption
- High capital investment

Chemical Recycling: ECO CIRCLE™ FIBERS by **Teijin**

- In principle, recycling of a mixed-fibre product is feasible but the end-product is restricted to mono-fibre articles like functional sports shirts from polyester

→ most recycled fibres are not made from post-consumer garments but from other sources of used plastics, such as PET bottles



© Source: Teijin

Chemical Recycling: ECO CIRCLE™ FIBERS by **Teijin**

Recycling of polyester from used-clothing, PET bottles & production waste PET

1. Material is cut and washed
2. Compounding / Solving in ethylene glycol
3. Reaction with methanol

- Commercially available process
- Similar quality as oil-based virgin materials
- Reduction in energy consumption by 84%

- System does not accept all polyester products
- 10 to 20% more expensive than using virgin materials
- No closed loop recycling as input is mostly no textile waste

© Source: Teijin

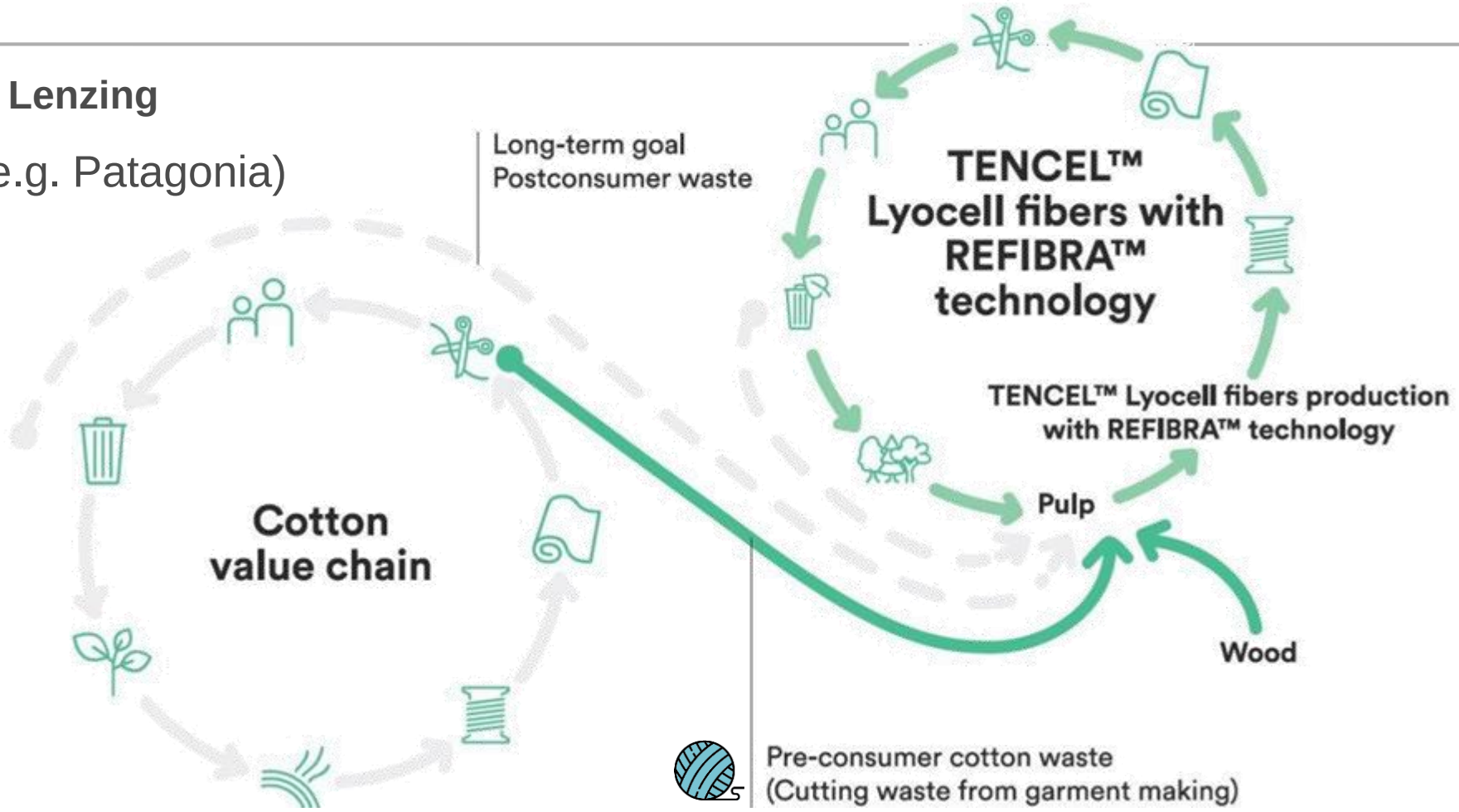
Fabric recycling of Pre-Consumer-Waste

- Natural and synthetic fibres
- Re-manufacturing: Pieces of complete fabric mostly from **factory offcuts** and **leftover materials** are **re-sewed** to create new garment
- Developed process not requiring advanced technologies
- Networking of companies in order to coordinate supply and demand of "pre-consumer-waste"
- Environmental-friendly
- 20-90% share of recycling content is possible
- Limited application (inconsistent and too-small supply of fabrics)
- Labour-intensive

Refibra

Lenzing

(e.g. Patagonia)

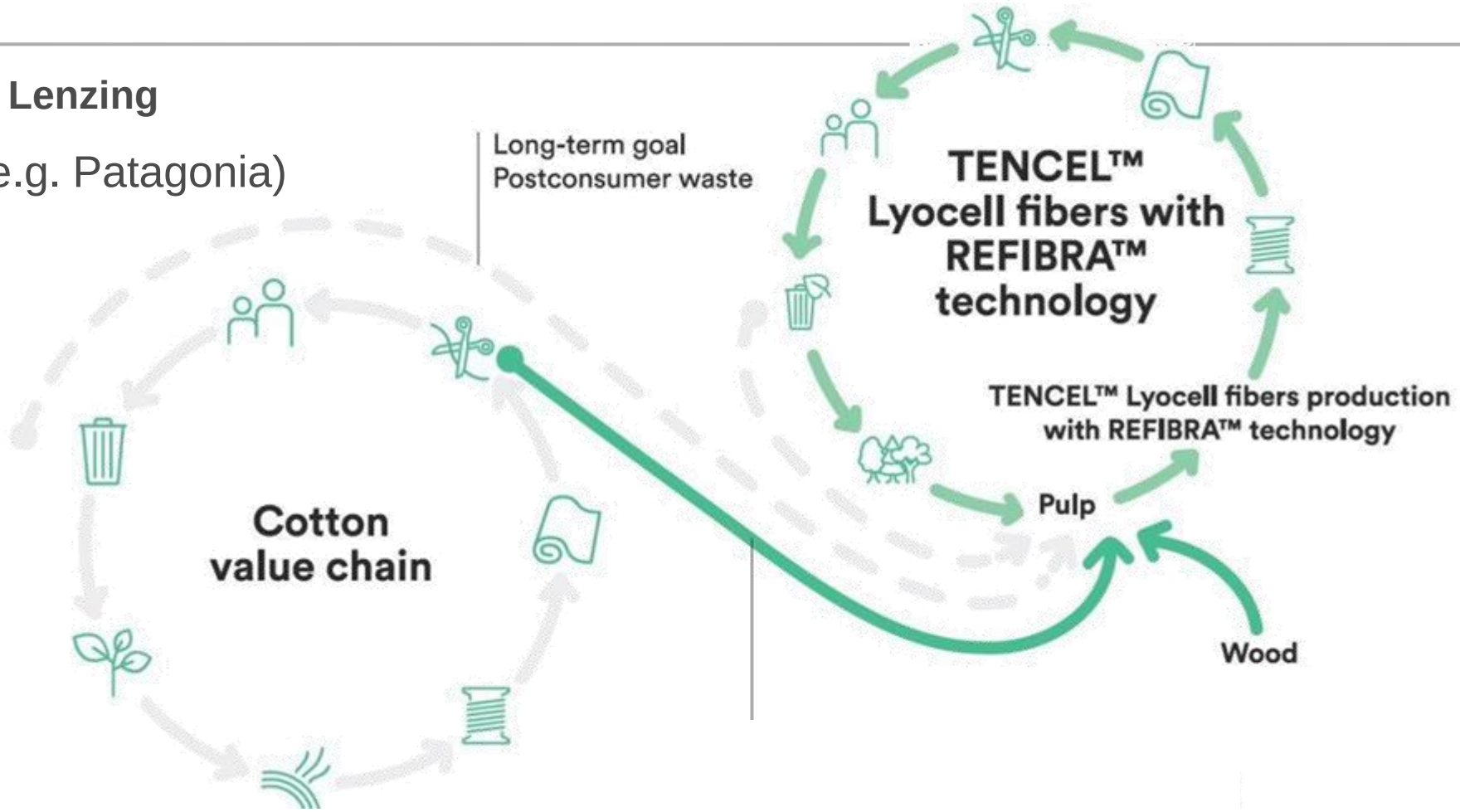


- Replaces part of wood as raw material used in pulp fibre production
- Commercially available
- Research on increasing recycling content and use of post-consumer waste

Refibra

Lenzing

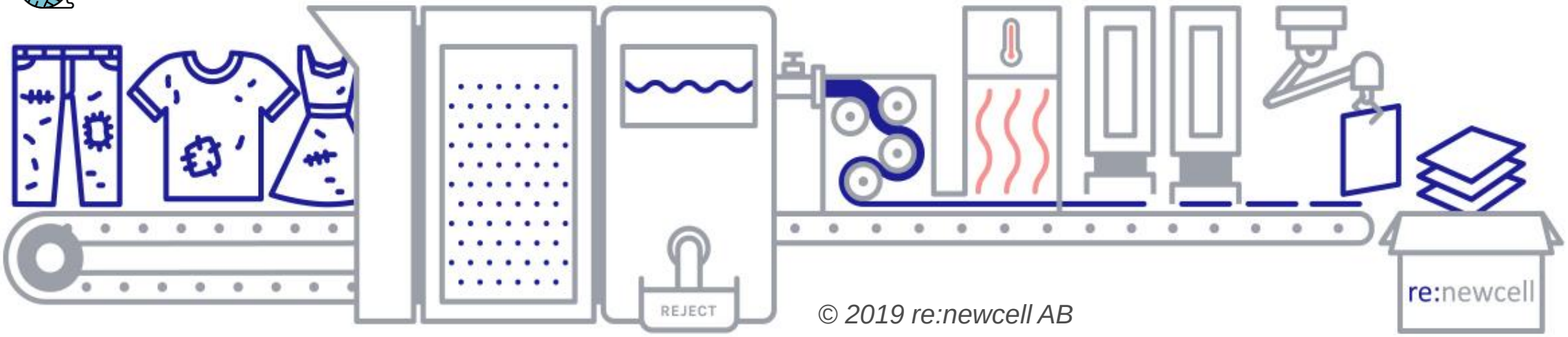
(e.g. Patagonia)



- Same quality as raw material from wood
- LCA-proofed environmental advantages
- Up to now just 20% recycling content possible
- Just possible for undyed, homogenous pre-consumer waste

re:newcell pulp

Cotton, viscose & other cellulosic fibres



- Post-consumer textiles are shredded, buttons removed, discoloured, etc.
- Separation of cellulose fibres

Chemical solvent
→ Molecular level
→ Dissolving pulp
→ Viscose fibre

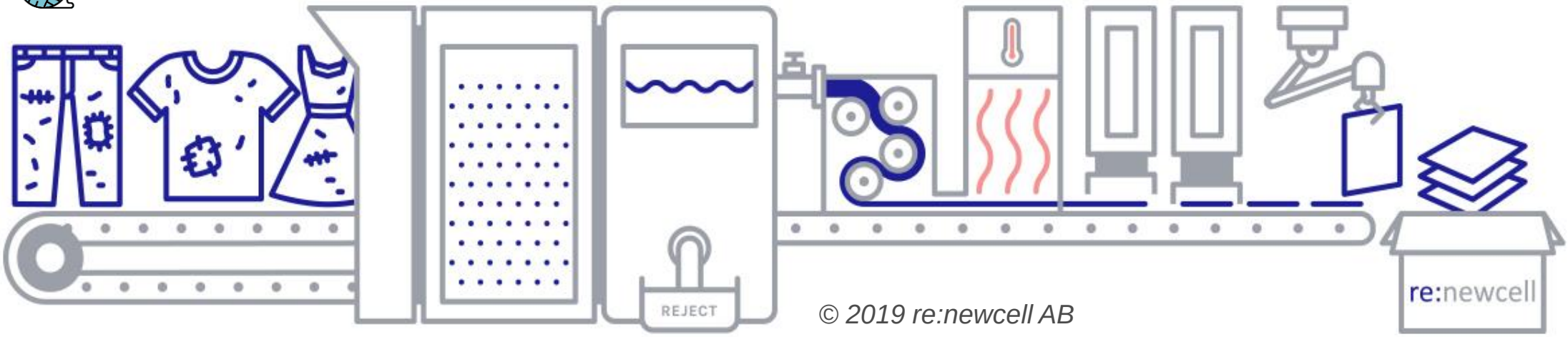
Drying
→ re:newcell pulp
→ packaged into bales
→ fed into the textile production cycle

Demonstration plant in Sweden producing 7,000 tons per year

full sale plants with 30,000 tons planned

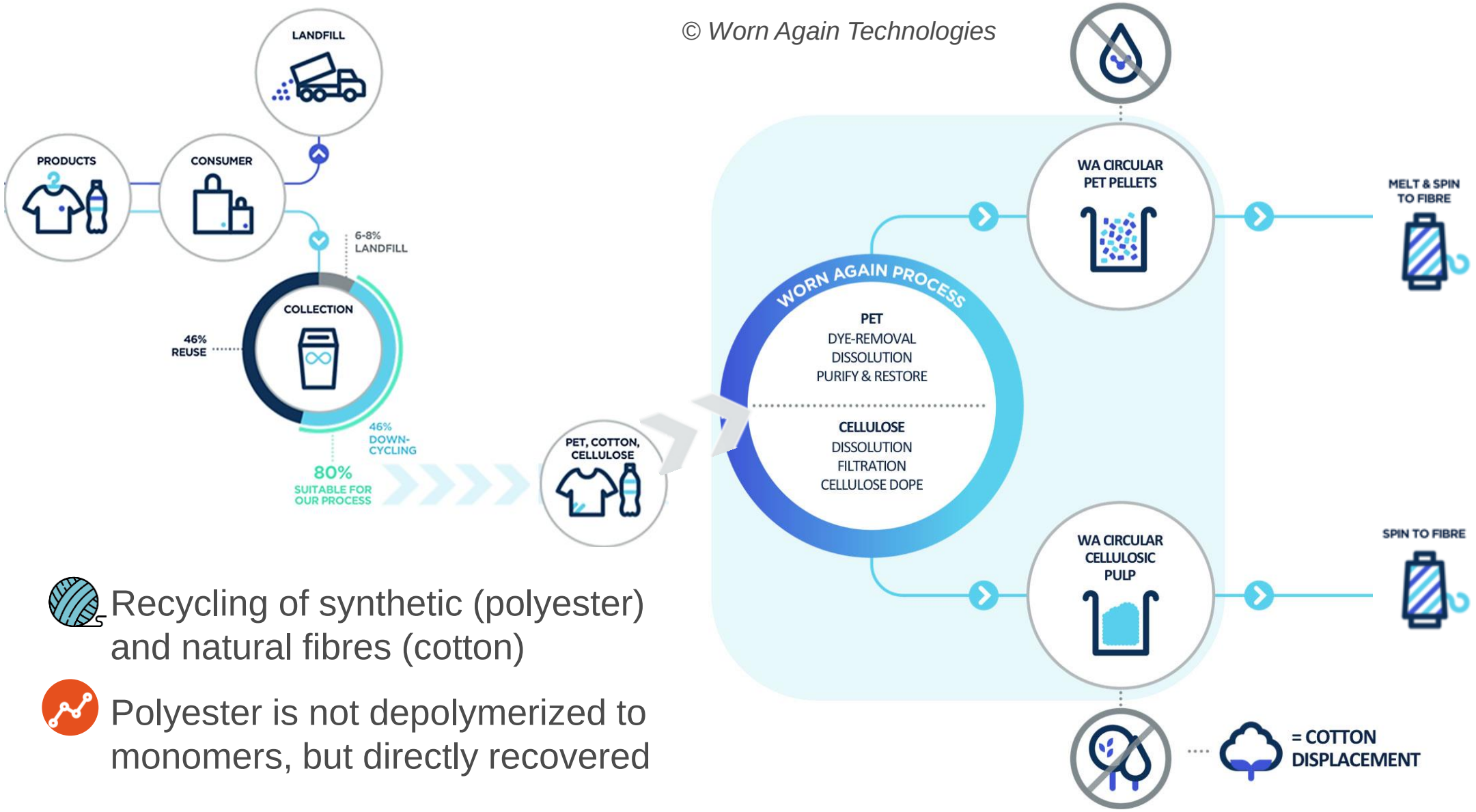
re:newcell pulp

Cotton, viscose & other cellulosic fibres



- Cost-effective environmentally friendly chemicals
- Low energy consumption (exception: drying)
- Quality problems with high non-cellulose content
- Broad spectrum of pollutants and dyes in the raw material
- Small scale leads to high costs in initial stage

Innovative chemical polymer recycling: Worn Again



- Recycling of synthetic (polyester) and natural fibres (cotton)
- Polyester is not depolymerized to monomers, but directly recovered

Innovative chemical polymer recycling: Worn Again

- Small scale
- Establishment of Recycling plants (Upscaling) planned
- Broad range of inputs
  → Pure as well as blended materials can be used
- 20% of impurities can be filtered out
- Polyester of same quality as virgin equivalent
- High energy consumption
- Higher costs than virgin materials

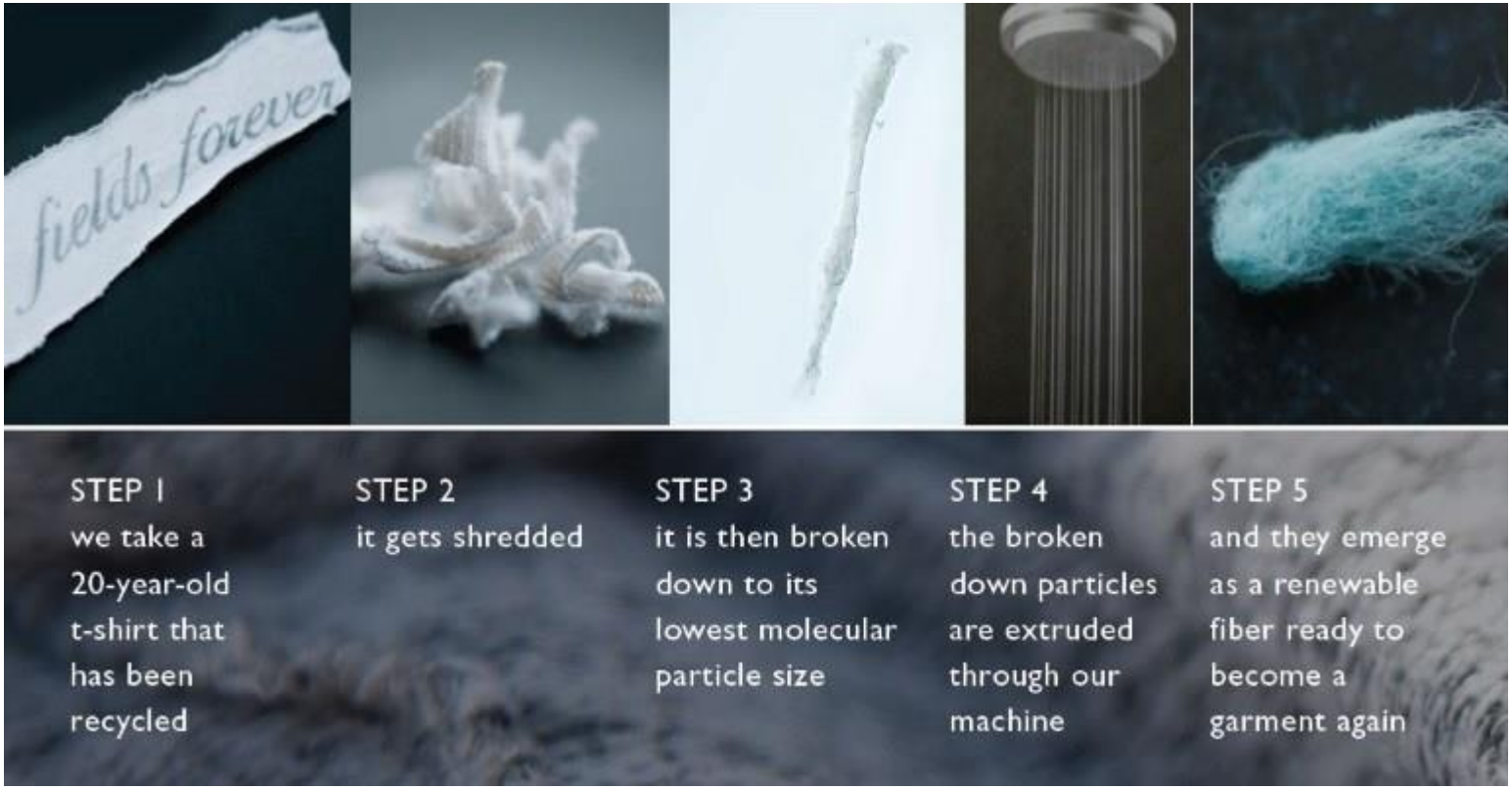
© Worn Again Technologies

Innovative chemical polymer recycling: Evrnu Regenerative Fiber

- Natural fibres (cotton fabrics)
- Prototype status

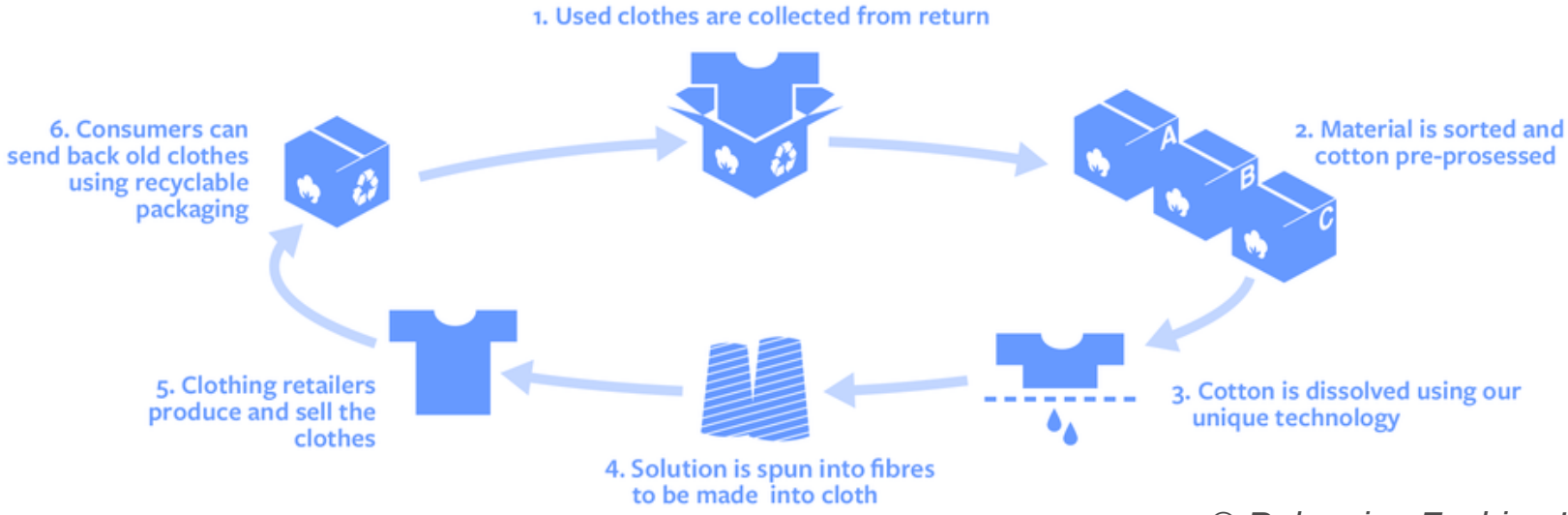
- Pulping and breaking down cotton to fibre molecules
- Removement of dyes / contaminates

- High quality fibres
- 98% less water than virgin cotton
- High energy consumption
- Higher costs than virgin materials



Relooping Fashion Initiative, Infinited Fiber

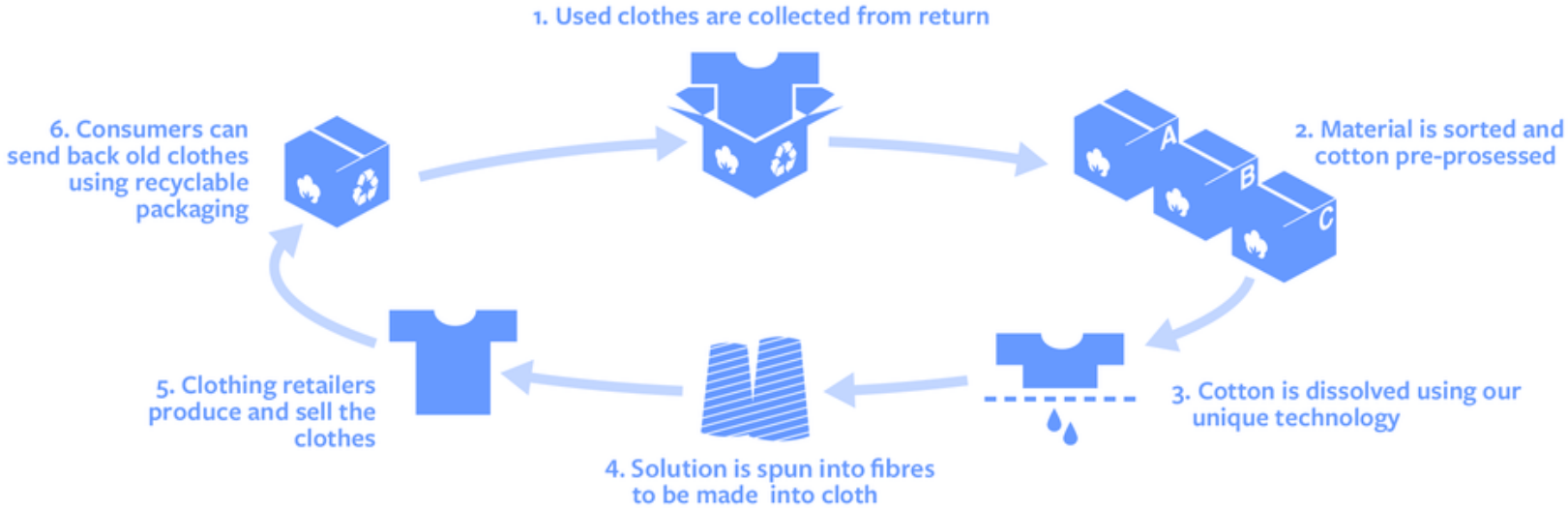
- Natural fibres (cotton rich textile waste and other biomaterials, like wood)
- VTT Technical Research Center of Finland, Infinited Fiber Company
- Unique cotton dissolving technology
  1. Activation
  2. Carbamate cellulose dissolution technique
  3. Fractioning
- Currently test-base on industrial scale, development towards industrial production



Relooping Fashion Initiative, Infinited Fiber

- Natural fibres (cotton rich textile waste and other biomaterials, like wood)
- VTT Technical Research Center of Finland, Infinited Fiber Company

- No downgrading of fibres
- Environmental-friendly
- Requires raw material in large quantities
- Reliability is an issue



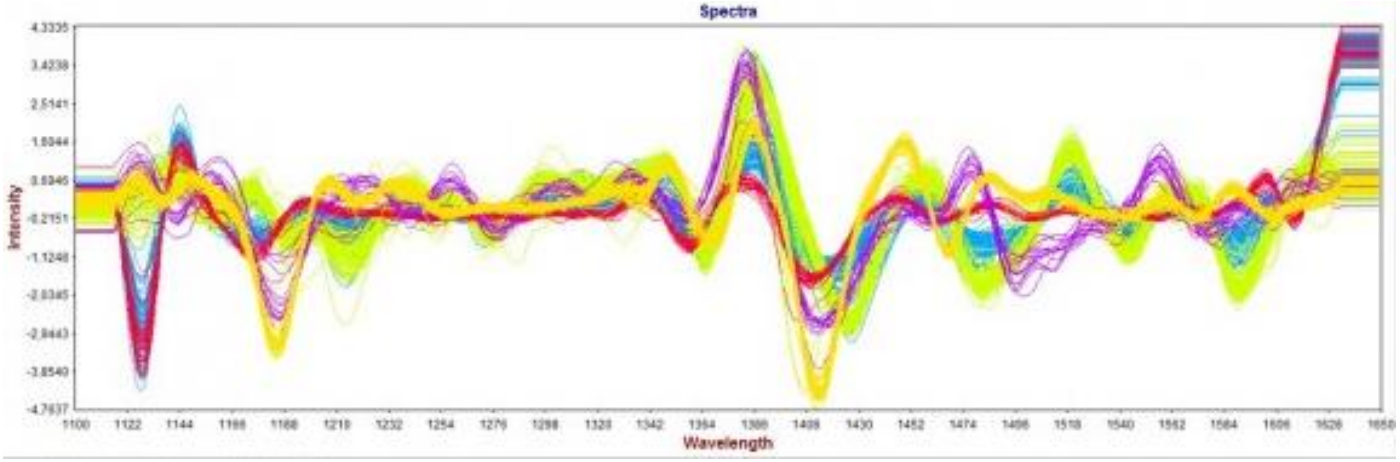
Innovative hydro-thermal (chemical) recycling

- Polyester and Cotton
- Hong Kong Research Institute of Textiles and Apparel (Partner: H&M)
- Hydrothermal process with heat, water and less than 5% biodegradable green chemical
- Pre-industrial size facility opened in September 2018 in Hong Kong
- Recycling of cotton and polyester blends
- Self separation without the need of prior high-quality sorting
- High energy consumption
- No direct textile-to-textile recycling for cotton

Textile Sorting Technologies

Sorting Technologies

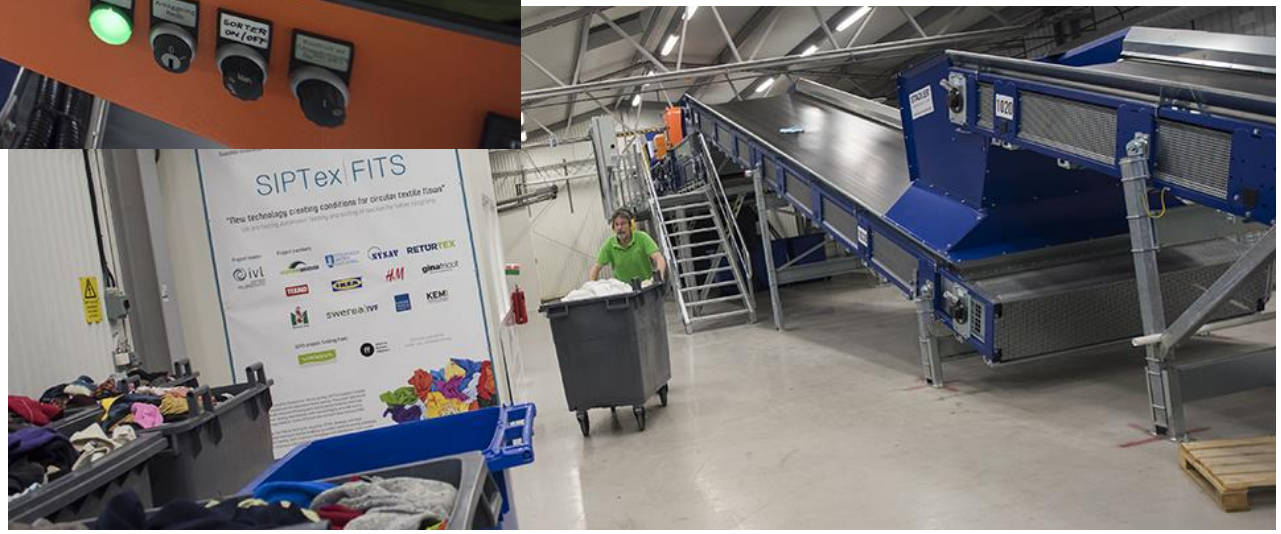
- Automatic sorting
- Near-infrared spectroscopy (NIRS)



- Visual spectroscopy
- Identification using RFID or bar codes
- Detection of cotton, wool, viscose, polyester, acrylic and nylon garments
- Separation of identified garments by compressed air
- Provides sorted, homogenous input for further recycling processes as a basis for further recycling steps

SIPTex (Swedish Innovation Platform for Textile sorting)

- IVL Swedish Environmental Research Institute
- Vinnova (+partners, e.g. Boer Group)
- NIR- spectroscopy & VIS technology



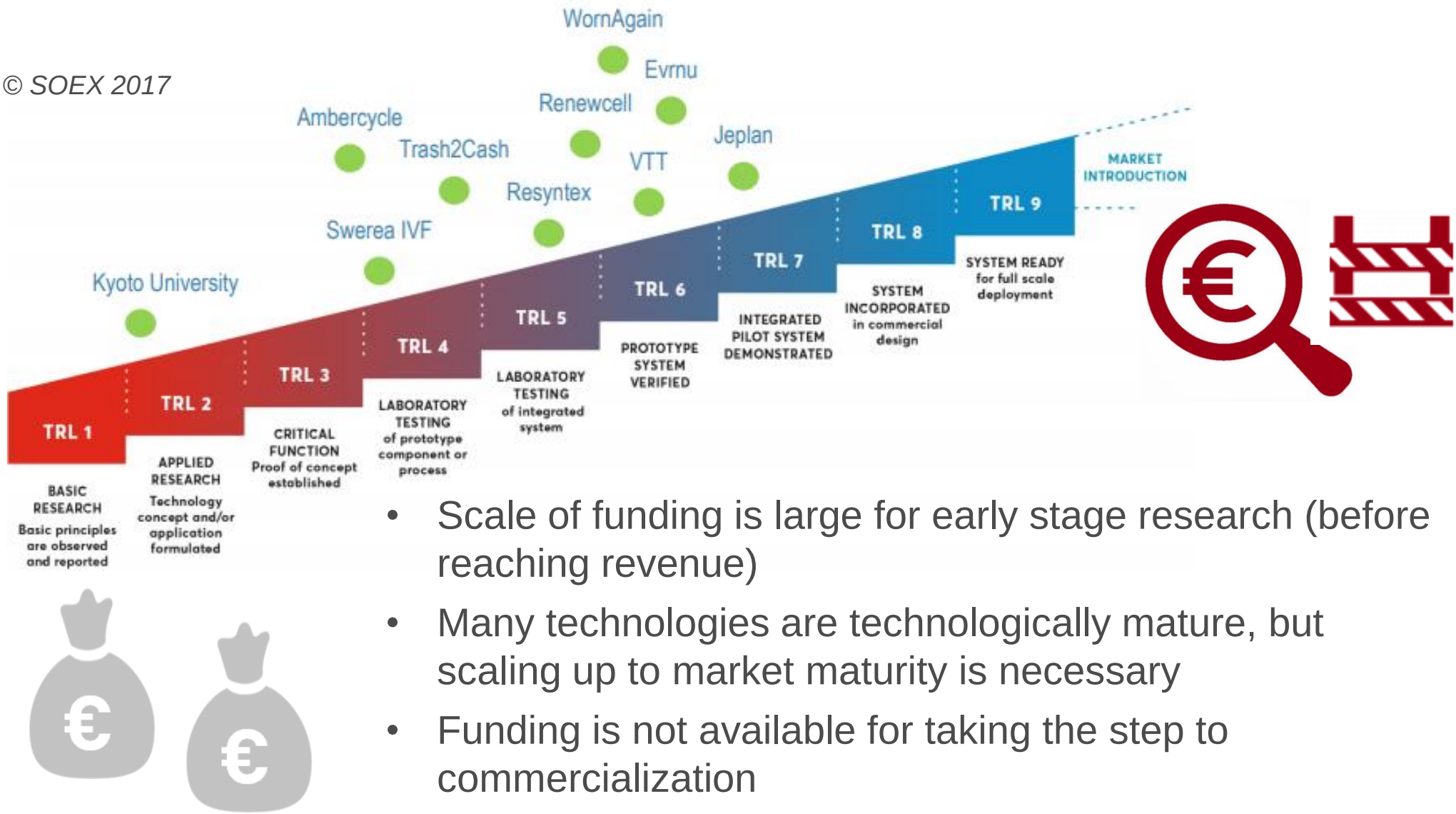
© Anette Andersson/IVL

FIBERSORT

- Circle Economy (with collectors, sorters, recycling experts)
- NIR- spectroscopy
- Precondition: at least 60 % of the detected fibre must be present in the mixture.

Barriers, Challanges & Solutions

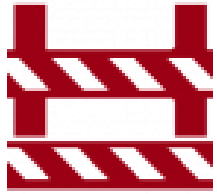
Financial barriers



- Scale of funding is large for early stage research (before reaching revenue)
- Many technologies are technologically mature, but scaling up to market maturity is necessary
- Funding is not available for taking the step to commercialization

Barriers & Challenges

- Fiber length decisive for application (downcycling, low price segment)
- Mechanical recycling not suitable for closing loops - due to shortened fibres only "downcycling" possible
- Problem “Fast-Fashion”



→Cheap synthetic fibres and blends have become the dominant components in the products of the fashion industry

→Lower Quality decreases recycling and Re-use potential

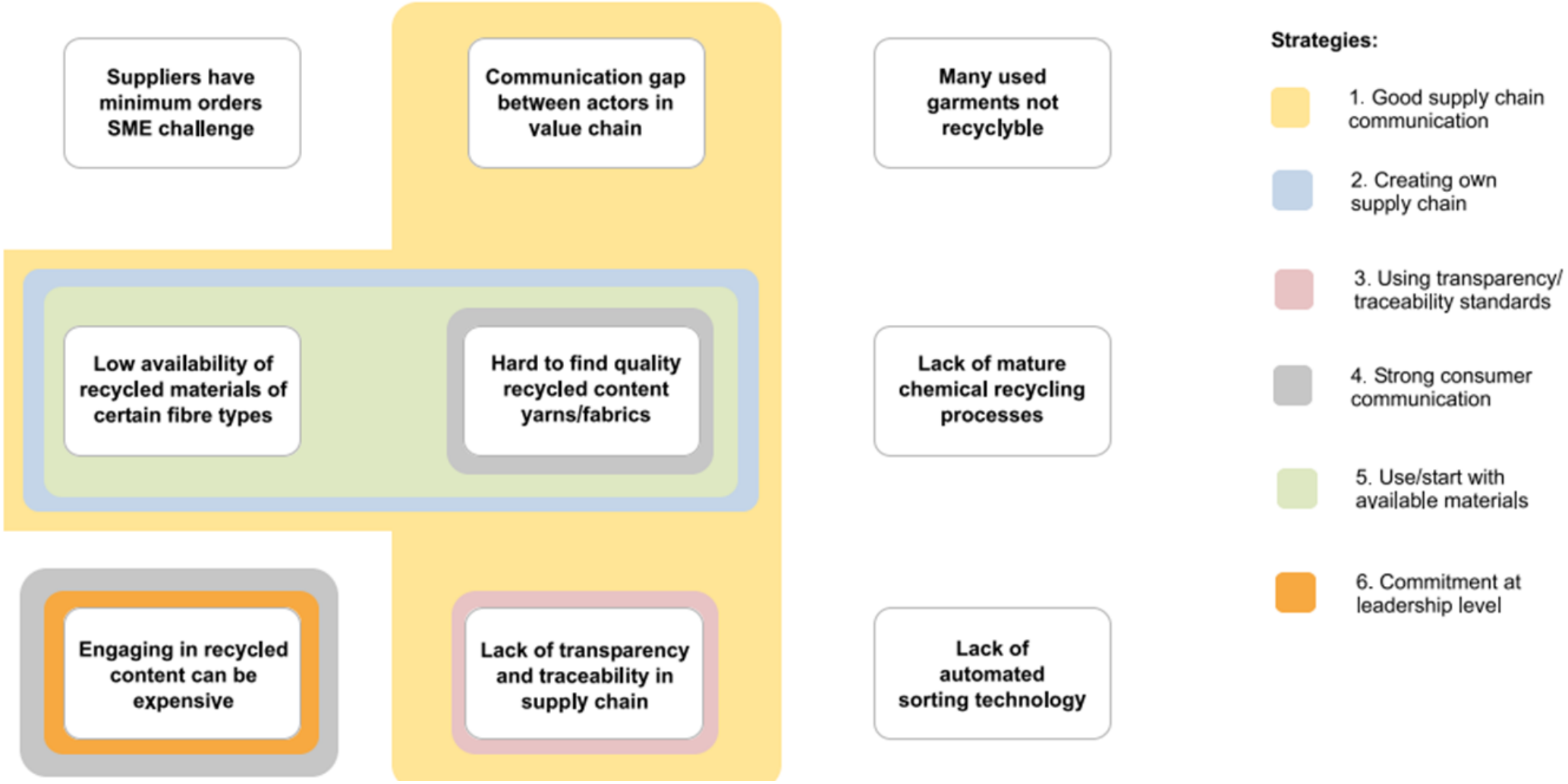
- Costs of collection and sorting are not covered by marketing revenues (marketing revenues from second-hand articles subsidise the fraction no longer wearable)

Barriers & Challenges

- Higher added value requires material purity, but there are almost only fibre blends left
- Limited purity of input fibers and energy costs turns out to be decisive for the higher price of recycled materials

- Lack of consumer awareness and education about circularity in textile schools (design)
- Limited exchange of information, low market penetration of innovative start-ups and path dependencies for incumbents in a highly competitive market environment
- Externalisation of costs, underdeveloped infrastructure for separate collection and recycling, textile exports and lack of financing

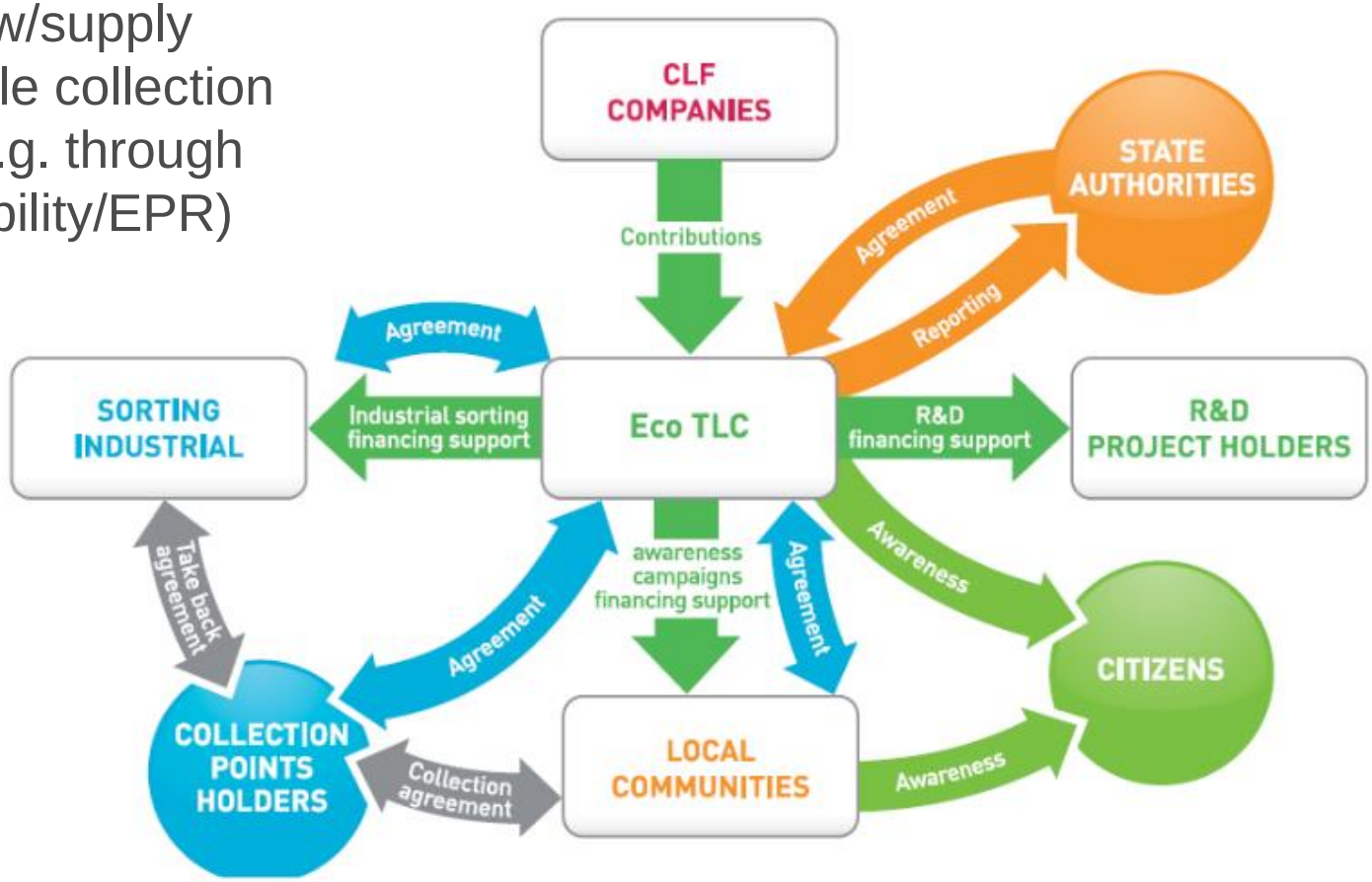
Strategies for use of recycled materials



Source: Norden 2017

Solutions & Best Practices

- Constant material inflow/supply through organised textile collection must be guaranteed (e.g. through manufacturer responsibility/EPR)
- Adequate framework conditions, incentive systems and research and development for recycling management principles in the textile sector

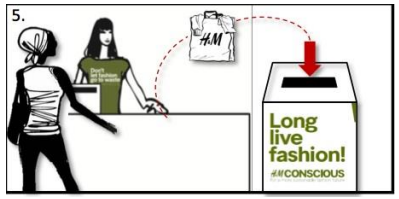


RESYNTEX

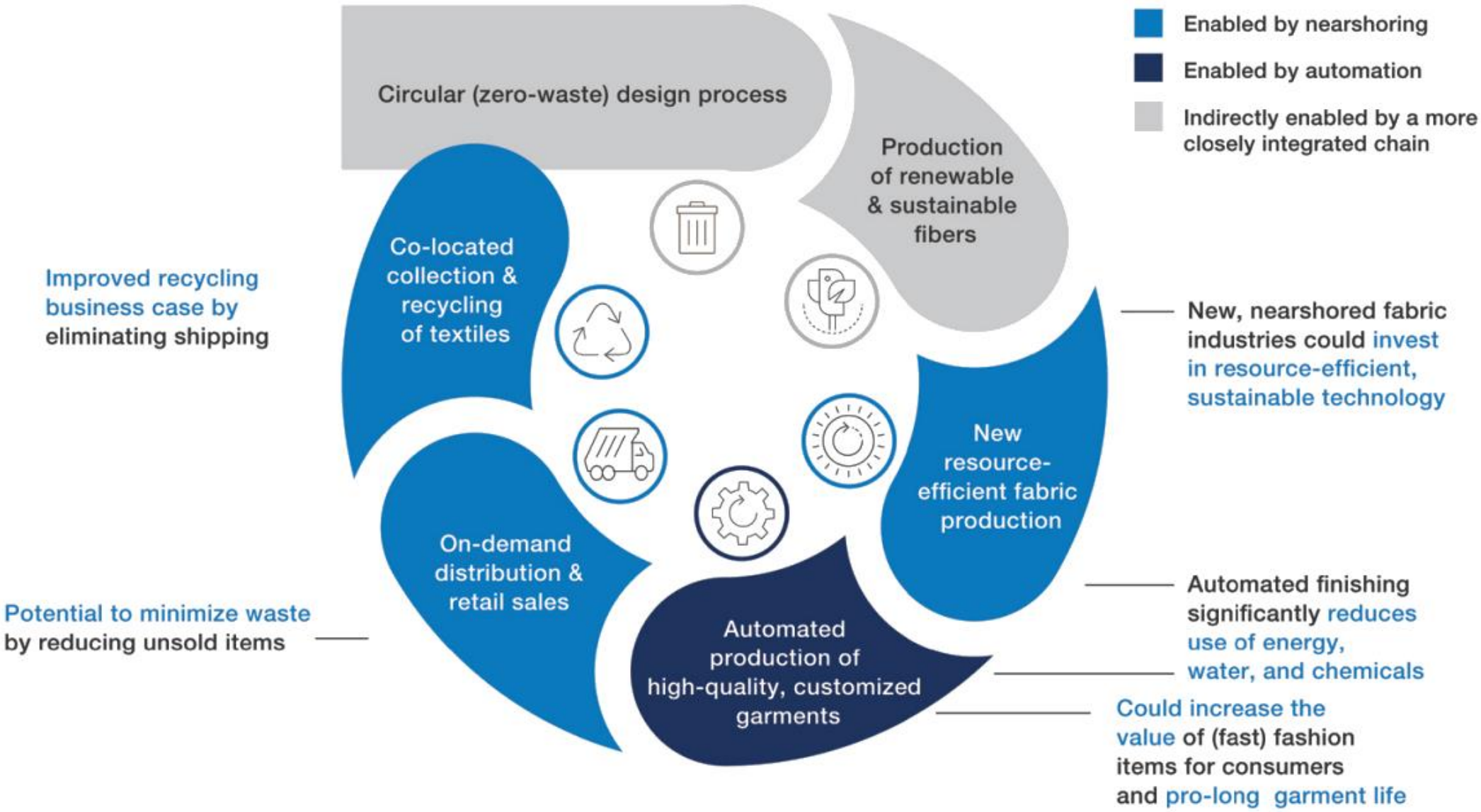
ECAP european clothing action plan

Life Project supported by LIFE funding

Filippa K Circle



Nearshoring & automation as enablers for a circular textile value chain



Source: McKinsey & Company, Is apparel manufacturing coming home?; Andersson et al. 2018

Conclusion

- Sorting technologies promising – however, separation only occurs by garment, not by fiber fractions
- Recycling of production waste (pre-consumer) promising due to purity of variety, no chemical additives or dyestuffs
- Facilitate the
  - creation of networks
  - trading platforms
  - and business models

  for manufacturing textile waste among production facilities in close spatial proximity
- Provide financial and technical assistance for upscaling of innovative design/recycling technologies for textile fibres

→ Collaboration across multiple actors and a holistic approach will be key


Questions &
Discussion

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